WATERTOWN ARSENAL LABORATORIES

IMPACT TESTS OF 9% NICKEL STEEL AT 11°K

TECHNICAL NOTE NO. WAL TN 302/4

BY
T. S. DeSISTO
W. L. WARNER

JANUARY 1960

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Impact steel alloy
Nickel
Stainless steel

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TITLE

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ABSTRACT

Charpy V notch and keyhole impact tests were made at -440°F (11°K) of Charpy specimens furnished by the International Nickel Company. These specimens were of both unwelded and welded plate of 9% nickel steel, Monel metal, and Type 304 stainless steel. The testing was done for the International Nickel Company under X.O. 96171.

T. S. DeSISTO
Mechanical Engineer

W. L. WARNER
Welding Engineer

APPROVED:

J. F. SULLIVAN
Director
Watertown Arsenal Laboratories

REPORT APPROVED
Date 4 Feb 60
WAL Board of Review
Chairman

MATERIALS

Charpy test specimens were furnished as follows:

9% Nickel Steel

Item	Quantity	Notch Type	Notch Location	Specimens
1	4	Vee	Weld	9W1-9W4
2	3	Keyhole	"	9W1-9W3
3	4	Vee	HAZ*	9Z1-9Z4
4	3	Keyhole	"	9Z1-9Z3
5	4	Vee	Weld	9WR1-9WR4
6	3	Keyhole	"	9WR1-9WR3
7	4	Vee	HAZ	9ZR1-9ZR4
8	3	Keyhole	"	9ZR1-9ZR3
9	4	Vee	BM**	9BL1-9BL4
10	4	Keyhole	"	9BL1-9BL4
11	4	Vee	"	9BT1-9BT4
12	4	Keyhole	"	9BT1-9BT4

Heat-Affected Zone
**Base Metal*

Items #1 through #4 were heat treated as follows:

Plate normalized at 1650°F
Plate normalized at 1450°F
Plate reheated to 1050°F for 2 hours

and the welds were made after cooling. Welds had no post heat treatment.

Items #5 through #8 had plate treated as above and then welded. After welding, the welds were heated at 1050°F for 2 hours.

Items #9 through #12 are unwelded base metal which has had the treatment indicated for Items #1 through #4. Specimens marked "L" are parallel to the principal rolling direction of the plate and those marked "T" are transverse to the principal rolling direction.

The plate was from Inco Laboratory Stock No. 03758 of the following chemistry:

Carbon	0.07	Silicon	0.25
Manganese	0.62	Nickel	9.0
Phosphorous	0.015	Chromium	0.12
Sulphur	0.006	Molybdenum	<0.05
		Aluminum	0.032

Welds were made with Inco-Rod A, 5/32" diameter, and transverse to the principal rolling direction of the plate. No other details given.

Monel Metal

Item	Quantity	Notch Type	Notch Location	Specimens
13	3	Vee	Weld	MW1301-1-MW1301-3
14	3	Keyhole	"	MW1301-1-MW1301-3
15	3	Vee	HAZ*	MZ1301-1-MZ1301-3
16	3	Keyhole	"	MZ1301-1-MZ1301-3
17	4	Vee	BM**	MB130L1-MB130L4
18	4	Keyhole	"	MB130L1-MB130L4
19	4	Vee	"	MB130T1-MB130T4
20	4	Keyhole	"	MB130T1-MB130T4

*Heat-Affected Zone
**Base Metal

Items #13 through #16 are welded with Inco M-130 electrode and are "as-welded." Items #17 through #20 are unwelded base metal. Marks "L" and "T" indicate specimens with major axis parallel and transverse, respectively, to the principal rolling direction of the plate. No welding details given.

Type 304 Stainless Steel

Item	Quantity	Notch Type	Notch Location	Specimens
21	5	Vee	Weld	304W1-304W5
22	4	Keyhole	"	304W1-304W4
23	5	Vee	HAZ*	304Z1-304Z5
24	4	Keyhole	"	304Z1-304Z4
25	4	Vee	BM**	304BL1-304BL4
26	4	Keyhole	"	304BL1-304BL4
27†	4	Vee	"	304BL5-304BL8
28†	4	Keyhole	"	304BL5-304BL8

*Heat-Affected Zone
**Base Metal
†Items #27 and #28 inadvertently marked as "Longitudinal" specimens; they were actually "Transverse."

Items #21 through #24 are welded with Type 308 stainless steel electrode, 5/32" diameter, and are "as-welded." Items #25 through #28 are unwelded base metal.

All Charpy specimens listed above were notched such that the notch axis is perpendicular to the original plate surface.

PROCEDURE AND RESULTS

All testing was done with specimens at a temperature of -440°F (11°K) and two sizes of pendulum were used. The data are as follows:

9% Nickel Steel

100 Ft-Lb Pendulum (V-Notch)

Specimen	Ft-Lb	Fracture (% Fibrous)	% through Weld
9W1	62.5	100	100
2	64.7	100	100
3	65.0	100	100
4	64.7	100	100
9Z1	62.7	100	100
2	68.5	100	100
3	52.8	100	100
4	73.0	100	100
9WR1	66.8	100	100
2	58.4	100	100
3	65.0	100	100
4	60.7	100	100
9ZR1	40.2	60	20
2	92.5	100	90
3	40.6	60	25
4	40.6	75	35
9BL1	14.1	20	0
2	14.1	20	0
3	12.9	20	0
4	16.3	20	0
9BT1	17.5	25	0
2	16.0	25	0
3	16.2	25	0
4	18.6	25	0

100 Ft-Lb Pendulum (Keyhole)

9W1	33.6	100	100
2	30.2	100	95
3	34.0	100	100
9Z1	32.9	100	50
2	27.2	100	50
3	31.5	100	50
9WR1	32.4	100	100
2	33.3	100	100
3	33.8	100	100

9% Nickel Steel (Cont'd)

100 Ft-Lb Pendulum (Keyhole) (Cont'd)

Specimen	Ft-Lb	Fracture (% Fibrous)	% through Weld
9ZR1	34.5	90	50
2	27.4	80	25
3	37.2	95	90
9BL1	15.4	20	0
2	22.0	20	0
3	34.0	30	0
4	16.0	20	0
9BT1	20.6	25	0
2	19.2	25	0
3	29.8	35	0
4	18.4	25	0

Monel Metal

100 Ft-Lb Pendulum (V-Notch)

MW1301-1	Did not break		
-2	Did not break		

200 Ft-Lb Pendulum (V-Notch)

MW1301-3	144.9	100	100
MZ1301-1	175.2	100	15
-2	184.4	100	0
-3	175.5	100	15
MB130L1	Did not break		
2	Did not break		
3	Did not break		
4	Did not break		
MB130T1	179.0	100	0
2	171.4	100	0
3	192.6	100	0
4	176.3	100	0

200 Ft-Lb Pendulum (Keyhole)

MW1301-1	51.9	100	100
-2	53.1	100	100
-3	51.1	100	100
MZ1301-1	79.3	100	0
-2	85.0	100	5
-3	78.1	100	0

Monel Metal (Cont'd)

200 Ft-Lb Pendulum (Keyhole) (Cont'd)

Specimen	Ft-Lb	Fracture (% Fibrous)	% through Weld
MB130L1	126.9	100	0
2	146.4	100	0
3	125.7	100	0
4	122.6	100	0
MB130T1	116.0	100	0
2	92.8	100	0
3	91.0	100	0
4	96.5	100	0

Type 304 Stainless Steel

100 Ft-Lb Pendulum (V-Notch)

304W2	21.8	Not possible to determine	
3	23.2	Not possible to determine	
4	25.3	Not possible to determine	
5	26.1	Not possible to determine	
304Z1	71.5	100	30
2	66.8	100	40
3	62.5	100	30
4	85.3	100	0
5	58.4	100	55
304BL1	Did not break		

100 Ft-Lb Pendulum (Keyhole)

304W1	20.6	Not possible to determine	
2	14.1	Not possible to determine	
3	19.0	Not possible to determine	
4	16.3	Not possible to determine	
304Z1	59.8	100	5
2	55.4	100	25
3	62.0	100	5
4	57.2	100	30
304BL1	70.8	100	0
2	70.0	100	0
3	70.8	100	0
304BL5*	77.0	100	0
6*	75.8	100	0
7*	67.6	100	0
8*	64.5	100	0

*Transverse Specimens

Type 304 Stainless Steel (Cont'd)

200 Ft-Lb Pendulum (V-Notch)

Specimen	Ft-Lb	Fracture (% Fibrous)	% through Weld
304W1	26.4	Not possible to determine	
304BL2	103.6	100	0
3	105.4	100	0
4	113.5	100	0
304BL5*	106.8	100	0
6*	119.1	100	0
7*	113.5	100	0
8*	101.4	100	0

200 Ft-Lb Pendulum (Keyhole)

304 BL4	64.9	100	0

*Transverse Specimens

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